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PROBLEMS IN AERIAL SURVEYS OF WATERFOWL IN EASTERN CANADA

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PROBLEMS IN AERIAL SURVEYS OF WATERFOWL IN EASTERN CANADA

by

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ABSTRACT

Experimental surveys of waterfowl breeding populations in eastern Canada have been conducted intermittently since 1949 to develop a procedure for making reliable estimates of breeding populations and production of black ducks and Canada geese in this region. This report reviews in detail the black duck breeding population surveys. The vastness of the breeding range precludes complete coverage; even the amount of sampling required for sound predictions is a major consideration. Several approaches to stratified sampling failed to produce a useful plan. Variations in phenology within the survey area appear to be a major factor in developing a reliable sampling plan; a method that takes these variations into account is presented. Analysis of data from 4 years gave trends in breeding population size that agreed generally with trends in corresponding winter population data; previous interpretation methods did not produce this agreement.

PROBLEMS IN AERIAL SURVEYS OF WATERFOWL IN EASTERN CANADA

This report discusses progress in the development of surveys to determine the number of waterfowl nesting in eastern Canada. Of the 15 species of waterfowl regularly observed during the experimental surveys, the species of primary interest are the black duck, Anas rubripes, and the Canada goose, Branta canadensis. Determining the status of these two species annually in eastern Canada is of major concern to those responsible for the management of waterfowl resources in Eastern North America.

The aerial surveys in eastern Canada usually cover in excess of 600,000 square miles, an area equivalent to approximately 17 percent of the United States. The surveys have not routinely included the Maritime Provinces of Canada, the New York - New England region or Michigan, all of which encompass important waterfowl breeding ranges in the East, and these areas are not discussed in this report. If these regions were included, the survey area would equal in size the United States east of the Mississippi River.

Results of aerial surveys in eastern Canada have been summarized annually in the Waterfowl Status Reports of the Bureau of Sport Fisheries and Wildlife. This report presents a more detailed examination of data relating to the black duck. In examining the survey data on the black duck, the primary consideration is development of an analysis that yields meaningful information.

History of Study

The first aerial surveys of waterfowl breeding populations in eastern Canada were flown in 1949. From 1949 to 1952, surveys were concentrated along the St. Lawrence River, the Lake St. John area of Quebec, Anticosti Island, New Brunswick, Prince Edward Island, and Nova Scotia (Hanson, 1955). Much of this work was exploratory. In 1952, for the first time, most of the flying was in Quebec and Labrador, but a part of eastern Ontario was included.

Two important changes were made in the survey procedures in 1953. The ¼-mile-wide overland (or straight-line) transect segments were changed in length from 10 minutes of flying time to 18 miles. In addition, two survey coverages were attempted in Quebec and Labrador; the second survey, conducted in July, was an attempt to determine the number of young produced by the breeding population recorded on the first survey.

In 1954, 1955, and 1956 no aerial survey was done in the Maritime Provinces. After 1954, shoreline transects were not flown. In 1957, the first survey (breeding population) was dropped. The second (production survey) was started but not completed because of mechanical difficulties with the aircraft.

In addition to the above surveys, Eklund and Cool (1949) made an exploratory aerial survey in the Ungava area of Quebec in 1949. In 1954, about 7,000 miles were flown in late August and early September to locate waterfowl concentrations for future banding stations.

After 1957, aerial surveys in eastern Canada were discontinued until 1962. The breeding population survey in 1962 started about 3 weeks late and, consequently, the data collected are not comparable with those of any other year. The production survey in 1962, as well as surveys in 1963 and 1964, started on time and yielded data that are comparable with those of earlier years.

Because of changes in method, coverage, and sampling intensity that occurred during earlier years, only data from the 1955, 1956, 1963, and 1964 surveys are discussed in this report.

The Problems

Many problems accompanied attempts to develop reliable aerial surveys in eastern Canada. The size of the area in relation to available manpower and equipment is a basic problem. The sex of the black duck, a species of major importance in the area, cannot be determined from the air. This complicates determination of the number of breeding pairs from the data. The density of breeding ducks in eastern Canada is comparatively low, creating sampling problems unlike those in the prairie regions of Canada. Weather problems can be placed in two categories, (1) annual variations in ice-free dates and (2) geographic variations in annual phenology within the survey area caused by differences in elevation and latitude. Also, extended periods of low clouds, fog, and rain often interfere with the survey schedule.

Operational problems include lack of navigation aids and aerodrome facilities. Inadequate or inaccurate charts have contributed to the difficulty of completing any given survey during the required time. These problems have been reduced since 1957. More airports and fuel facilities have become available. More weather reporting stations and navigation aids have come with the airports. National defense installations, mining operations, and hydroelectric systems

have made changes on the face of the land, although the first-time visitor still is impressed by the vast areas in which no signs of man's activity are apparent. In spite of the improvements, there are still several locations where it is necessary to stockpile fuel and oil for next year's survey.

Stratifying Samples According to Black Duck Densities

Identification of discrete areas having either high or low densities of black ducks would allow stratification of aerial sampling. Such treatment would strengthen the basis for population estimates. Previously, those who examined aerial survey data from eastern Canada referred to five strata based on forest types (fig. 1). Our recent analysis of the data indicated that it was not possible to demonstrate statistically significant differences in black duck density among these strata.

Since we believed that forest-type strata might be too large to show population differences, we divided the surveyed area into 15 units based upon both topography and forest types. Units not only showed great differences in black duck densities for any given year, but also varied among years to such an extent that they appeared to be of no value as stratified samples. Further, using the 15 units, we found no correlation between the quantitative results of the production survey and those of the breeding population survey. In other words, the two surveys did not appear to be sampling the same population of black ducks when the data were examined in this manner.

Degree blocks of latitude and longitude were used as areal units for examining the distribution of observed black ducks. The data for degree blocks were summarized as ducks per 18-mile segment of transect, since the number of transect segments per block was not uniform. This plan permitted comparing data for all 4 years even though transects in 1955 and 1956 were at different locations from those in 1963 and 1964.

A degree block in eastern Canada contains approximately 3,000 square miles. Transects were spaced about 1 degree apart and averaged about 2.5 segments per degree block. For this reason, an analysis of degree blocks as reference units departs little from an analysis by 18-mile segments.

A frequency graph (fig. 2) of black ducks per segment in the 312 degree blocks sampled over a 4-year period shows a distribution strongly skewed toward zero. Black ducks per segment averaged 1.3

in degree blocks; the median number was 0.8 and the mode 0.0. Because of the high frequency of degree blocks containing no observed black ducks and the occasional degree block with disproportionately high numbers, the median was used to divide the degree blocks into high and low density categories for examining distribution patterns.

Since there are two alternatives in each degree block (above or below median), it is possible to state the amount of agreement between years among the matched degree blocks, to compare the result with the 50 percent agreement expected from chance, and to learn if there is a consistent distribution pattern upon which to base a stratified sampling plan.

Comparison of the distribution pattern of 1955 with that of 1956 showed an amount of agreement (67 percent) which exceeded the 99-percent confidence limits (34 percent to 66 percent). Comparisons of other possible combinations of years did not reveal significant agreement, as shown in the following table. Comparison of the 1963 and 1964 patterns involved identical sample segments, as did comparisons between the two earlier years, but the amount of agreement did not differ much from that expected by chance.

Years compared	Percent agreement
1955 and 1956	67
1955 and 1963	51
1955 and 1964	47
1956 and 1963	44
1956 and 1964	44
1963 and 1964	51

Ten of the degree blocks were consistently above or below median for all 4 years. Nine such occurrences (one-eighth of the sample) are to be expected from chance.

These comparisons indicate that degree blocks do not seem to provide a basis for stratification of the black duck survey, since the counts divided in this manner show inconsistencies between years. Although there was some agreement on a similar pattern in the surveys of 1955 and 1956, that pattern did not agree with the pattern of the two recent years of survey. Also, patterns in the two recent years of survey show little agreement with each other. Our inability to detect consistent differences in the density of black ducks may be due to (1) a relatively even dispersal of black ducks in the area, (2) a sample too small, in numbers of birds seen and intensity of coverage, to detect differences in density that

may occur, or (3) an obscuring interaction between phenology in various portions of the survey area and timing of the survey. Reason 3 will be discussed further in another section of this report.

As a third method of distributing data, 75 contiguous degree blocks were arbitrarily grouped by 4 different methods into 5 units of 15 blocks each. Counts for the 4 years in these larger units were examined using an analysis of variance to separate differences due to years from differences due to areas.

Analysis of variance showed a significantly high variance ratio for each arrangement except one. The highest variance ratio ($F = 4.31$ with 4 and 12 degrees of freedom) was obtained from the third pattern (fig. 3).

These analyses suggest that highest counts of black ducks have been obtained from the west-central portion of the area surveyed, an area lying about one-third of the distance from the Great Lakes to James Bay. Evans (1956), from study of the distribution of aerially observed breeding populations (all species) in northeastern Canada between 1952 and 1956, suggested that higher counts of birds in a zone north of the Great Lakes were due to "pile-up," a stall in migrational movement caused by unsuitable climatic conditions further north.

Establishing the Phenology of the Nesting Cycle

The likelihood of observing black ducks from aircraft and the frequency of the various group-sizes in which black ducks occur are probably related to the phenology of the area. Early in the spring there may be a high occurrence of flocked black ducks that are migrating northward or are "piled-up" and waiting for milder weather before continuing northward. Wright (1954) described the spring flight of blacks to a New Brunswick study area as an arrival mainly in pairs. About 2 weeks after the arrival of the first pairs, a "wave" of unpaired blacks passed through. Stotts and Davis (1960) indicated that in Maryland the peak period of pairing of blacks occurred in December and January. Consideration of these observations would suggest that counts showing a high frequency of pairs and flocks relate to an early stage in the nesting season for the area surveyed.

As the nesting season progresses, the female becomes increasingly attached to the nest site, flushes less readily, and flies shorter distances when startled (Stotts and Davis, 1960). Thus, the observation of lone males on territory should predominate in aerial counts

during the first part of the incubation period. During the latter part of the period, males may desert their mates and associate with other males. Stotts and Davis, from seven examples of male attendance after incubation began, found that desertions by the male averaged about midway in the incubation period. At this point, aerial crews may again see paired or small groups of birds which consist entirely of males. Later the postbreeding males may congregate in larger groups in conjunction with nonbreeding males. This phase in the nesting season should be marked by flocked birds once again, as in the early phase. However, the number of observations of paired birds should be lower than in the early phase.

In addition to the numbers of pairs and flocked birds, the number of groups of three may have significance in nesting phenology. Groups of three are likely to be males in an early stage of postbreeding congregation, and would not be expected in the early phase when groupings are predominantly pairs and large flocks.

The relations of group frequencies to the stages of the nesting season are summarized below:

Stage of the nesting season	Aerial observations
Early	More pairs. Fewer singles. Fewer groups of 3. More Large groups (5 or more).
Middle	Pairs intermediate. Singles intermediate. Groups of 3 intermediate. Fewer large groups.
Late	Fewer pairs. More singles. More groups of 3. More large groups (5 or more).

Counts of black ducks, owing to their low density over large areas, are probably more subject to bias from phenological differences than are those of other major species of waterfowl. With our present sampling procedure, one or more flocks of birds may increase the count inordinately. Removing flocked ducks from the count and including only pairs and lone ducks (doubled) is probably not an adequate solution to the problem. Surveys of black ducks are complicated by the

lack of sexual dimorphism in the species. A flock may consist of unsegregated pairs or of postbreeding drakes. Both are important in indicating the size of the population.

The ideal aerial count of black ducks would sample the entire area at a specific phase of the nesting cycle. Since this is not feasible, an alternative may be to select samples with similar frequencies of groupings (singles, pairs, flocks, etc.) for comparison under the hypothesis that these samples are likely to be most similar in nesting phenology.

Stratifying for Phenological Differences

The area of Canada that was sampled consistently for 4 years was divided into southern, central, and northern zones (fig. 4). This arrangement is most likely to delineate phenological units, since in the south the nesting season may be well advanced while nesting has not begun in the north. Although the aerial survey begins in the south and progresses northward, it very likely occurs relatively late phenologically in the south and becomes progressively earlier phenologically as it proceeds northward.

The total number of black ducks and the frequency per segment of the black duck groupings discussed above were ascertained from each year's records for each zone. The values obtained are shown in table 1.

Frequencies obtained for each grouping were ranked as high, medium, or low, in relation to the mean frequency for the zone based on a 4-year average. Values falling within the range of the mean plus or minus 2 standard errors were considered medium. Values outside that range were considered highs and lows.

The number of high and low values obtained (31 percent) is greater than the 5-percent figure which usually is expected to exceed 2 standard errors. This indicates that these data depart greatly from a normal distribution. The object in using 2 standard errors, however, was not to describe variability but to apply a consistent, mechanical method for dividing the data into classes.

A quantitative estimate of agreement or disagreement in characteristics between any two zone-year groups was obtained by assigning a value of 2 when items agreed (high-high, low-low, medium-medium), a value of 1 for partial agreement (high-medium or low-medium), and no value for complete disagreement (high-low).

Phenological comparability in each of the four grouping characteristics would provide a maximum agreement index of 8. Results of this treatment are presented in table 2.

To compare counts obtained in 1955 and 1956 with counts in 1963 and 1964, data in each zone may be selected from one of the two earlier years that are most comparable to data from one of the two later years. In the southern zone, the highest agreement index (8) was obtained from comparing 1956 with 1963. Those years showed an 8-percent drop in black ducks per segment between the mid-1950's and the early 1960's. In the central zone, the procedure indicated that the years 1956 and 1963 were most comparable (agreement index = 7). Comparison of ducks per segment indicated a decrease of 21 percent between 1956 and 1963. In the northern zone, 1955 and 1964 appeared most similar (agreement index = 6) and showed a decrease of 10 percent between 1955 and 1964.

To compare consecutive early years (1955-56) or consecutive late years (1963-64), we selected the zone which showed the highest agreement index and assumed that this zone was a valid indicator of differences. Between 1955 and 1956, the southern zone showed an index of 7, while the northern zone had an index of 6 and the central zone an index of 5. The comparison with the highest index (the southern zone) indicated a drop of 8 percent between 1955 and 1956. When we examine 1963 and 1964, the southern zone again had the highest agreement index (7), and the data indicated an increase in ducks per segment of 38 percent.

In summary, the above procedure showed a decrease in black duck populations from the mid-1950's to the early 1960's, a decrease from 1955 to 1956, and an increase from 1963 to 1964, if the assumption is correct that the zones and years selected for comparison are representative.

Adequacy of Current Survey Procedures

Indexes available for examining black duck population trends include the winter survey, densities of black ducks observed during surveys on the breeding grounds, and the results of the group-characteristic procedure applied to breeding population survey data.

Table 3 shows the indexes from the above sources for the years 1955, 1956, 1963, and 1964. The trend of each index is presented graphically in figure 5.

Evidence from band recoveries indicates that the black ducks using the survey area provide most of the population that winters in the northern part of the Atlantic Flyway. Many black ducks wintering in the southern part of the Atlantic Flyway originate in the surveyed area also, but here they are mixed with black ducks which originate west of the surveyed area. The effect of this western component may be insignificant, but our knowledge of its influence is very inadequate at this time. Because of this, the winter survey data are shown for both the total Atlantic Flyway and that portion of the flyway north of Maryland.

Breeding population survey figures were based upon matched transect segments in 1955 and 1956, and in 1963 and 1964, but were not matched between 1955-56 and 1963-64. Also, in 1955 and 1956, the area surrounding Knob Lake and Goose Bay was intensively sampled. In 1963 and 1964, only a small sample was drawn. To avoid a possible bias from uneven sampling intensities, the Knob Lake - Goose Bay area data were omitted from all 4 years. Inclusion of these data would have increased the upward trend from 1955 to 1956, for the change in that area was more marked than the overall change, as shown in the following table:

Area	Segments		Black ducks		Ducks per segment	
	1955	1956	1955	1956	1955	1956
Knob Lake - Goose Bay	95	95	104	151	1.09	1.59
Other	227	227	300	324	1.32	1.43
Total	322	322	404	475	1.25	1.48

To determine population trends from the group-characteristics procedure, it was necessary to assign hypothetical population sizes to demonstrate the percentage changes. In assigning these values, the change between the 1955-56 and 1963-64 sets of data was considered primary. An arbitrary mean value of 10,000 was given to the 1955-56 population of black ducks. The group-characteristic procedure indicated that there was an average 13-percent decrease between the 1955-56 and the 1963-64 periods (southern zone, 8 percent; central zone, 21 percent; northern zone, 10 percent). Hence, the mean value assigned to the 1963-64 period was 8,700, or 13 percent less than the value for the 1955-56 period.

The group-characteristic procedure suggested an 8-percent decrease between 1955 and 1956 and a 38-percent increase between 1963 and 1964. Values about a mean of 10,000 that showed an 8-percent decrease were

10,385 and 9,615 and were assigned to 1955 and 1956, respectively. The values about a mean of 8,700 that reflected a 38-percent increase were 7,310 for 1963 and 10,090 for 1964.

These hypothetical population values, created for trend information only, are compared with winter and breeding ground survey statistics in table 3. Graphic presentation in figure 6 shows directional agreement in trends for the group-characteristics procedure and the winter survey for the Atlantic Flyway. Winter survey data are shown as flyway totals and also as totals for States north of Maryland. The group-characteristics procedure results show closer agreement with the winter survey for the States north of Maryland than with the winter survey for the whole flyway.

The breeding population survey index differs markedly from the others, particularly in 1963. Referring back to table 1, we note that the number of black ducks per segment in the northern zone in 1963 was about double the figure for any of the other 3 years. The group-characteristics in the North in 1963 showed highest values of any year for paired birds, single birds, and flocked (five or more) birds. This pattern could mean that at the time of the 1963 survey nesting was in an early stage, but at the same time there was an influx of postbreeding males from the South.

Discussion

The group-characteristic method of computing annual changes in black duck breeding populations seems to improve the reliability of the data. This is evidenced by its directional agreement with the population trend shown by the winter inventory data. There is considerable variation in the degree of trend between the two independent sources of data, and the reliability of the annual percentage changes in the new method may be quite low. Since it appears that the cost in time and money necessary to develop a statistically reliable quantitative measure of a sparse population of ducks scattered over a large area would be prohibitive at the present time, the group-characteristic procedure, which indicates trend only, may be, despite its shortcomings, the best possible alternative. The bias in selecting certain zone and year combinations as representative of the total population may be less misleading than accepting the total annual sample each year with no regard for evidence of phenological disparity.

At present, the group-characteristic procedure is considered exploratory and tentative. The approach, as outlined in this report, should be considered preliminary. Modification may be indicated

by future data collecting and analysis. Possibilities that can be foreseen include modifications of area boundaries according to average seasonal phenology (which does not proceed evenly from south to north), delineation of most consistent areas from the phenological standpoint, and modification of the mechanics of evaluating waterfowl groups and numbers observed.

As our knowledge of the distribution of breeding black ducks increases, accuracy in measuring the size of the black duck breeding population can be improved in a number of ways. The boundaries of the breeding range to be surveyed can be better defined. In this regard, exploratory transects have been flown adjacent to the area regularly surveyed and data have been gathered from west of James Bay and in the New York - New England area. Some areas still to be considered include the coast of Labrador, Newfoundland, Nova Scotia, and northern Michigan. Since the harvest potential of the various black duck breeding populations is of major concern to those responsible for the management of the resource, this factor must be considered in the final decisions on what populations shall be permanently included in the survey area.

Analysis of data collected to date has not led to a useful stratification of the black duck breeding range based upon differences in density of breeding birds. A stratification based upon differences in phenology offers promise in helping to reduce a bias. In this connection, the possibility that coastal areas should be sampled as a separate stratum will be examined.

Determining the annual status of the black duck breeding population on a continental basis is an immediate management goal; however, the status of subunits within the total population also has important management significance. As techniques improve, this further refinement should be viewed as a long-range goal.

There are a number of objectives of aerial surveys of waterfowl in eastern Canada which have not been discussed in detail in this report. One of these, the production survey conducted in July, attempts to measure waterfowl production. Recently, special effort has been made to band samples of immature and adult black ducks before the hunting season in Canada and the Northeastern United States. If this effort is successful in obtaining representative samples of the pre-hunting-season black duck population, useful information can be derived from the band recoveries. When banding data are combined with data from the Bureau's annual wing collection survey, an estimate of the age composition of the pre-hunting-season black duck population can be made. Age composition data, taken over a period of years, provide an indicator of annual production and show whether production is variable or uniform from year to year.

If the results indicate nearly constant production, the necessity for an annual production survey will be questionable. If, on the other hand, black duck production varies a great deal from year to year, the size of the fall flight will vary also and it will be necessary to detect annual changes in production before the flight. Since present data do not rule out the possibility of variable annual production, plans must be made to continue and refine the duck production surveys in eastern Canada.

It may be possible to estimate black duck production each year from phenological data gathered in May. If further study demonstrates a relation between the phenology of the nesting cycle and annual production among black ducks in eastern Canada, the value of phenological data gathered in May and June will be greatly increased.

While the Canada goose and the black duck are unquestionably the species of major concern in eastern Canada, valuable data are recorded for many other species of waterfowl while the surveys are being conducted. Frequently, one-half to two-thirds of the ducks observed are species other than the black duck, most commonly mergansers, Mergus spp., and goldeneyes, Bucephala clangula americana. In recent years, there has been a substantial increase in the number of mallards, Anas platyrhynchos platyrhynchos, observed. Evaluating the status of these species in eastern Canada should be included in the overall objectives of the surveys.

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Table 1.--Characteristics of black duck counts from breeding population surveys in eastern Canada, 1955-56 and 1963-64

	Frequency per segment				
	Pairs	Singles	Groups of 3	Groups of 5 or more	Ducks per segment
Southern Zone					
1955	.306(M)[1/]	.245(M)	.061(H)	.000(M)	1.04
1956	.307(M)	.224(M)	.000(M)	.000(M)	.96
1963	.259(M)	.190(M)	.000(M)	.017(M)	.88
1964	.254(M)	.460(H)	.016(M)	.016(M)	1.21
$\bar{x} \pm 2$ S.E.	.244-.348	.160-.400	.000-.048	.000-.017	
Central Zone					
1955	.275(M)	.261(M)	.058(H)	.101(H)	2.13
1956	.754(H)	.333(M)	.029(M)	.029(M)	2.35
1963	.433(M)	.300(M)	.050(M)	.067(M)	1.85
1964	.340(M)	.420(H)	.020(L)	.020(M)	1.54
$\bar{x} \pm 2$ S.E.	.236-.664	.260-.396	.021-.057	.017-.091	
Northern Zone					
1955	.247(M)	.188(M)	.059(M)	.024(M)	1.10
1956	.141(M)	.070(L)	.000(L)	.059(M)	0.99
1963	.330(H)	.250(H)	.034(M)	.068(H)	1.89
1964	.170(M)	.182(M)	.080(H)	.011(L)	0.99
$\bar{x} \pm 2$ S.E.	.137-.307	.097-.247	.007-.079	.013-.067	

[1/] Letters indicate classification as high, medium, or low with regard to the frequency of various group sizes in relation to the mean frequency for the area over the 4 years.

Table 2.--Comparability indexes for groupings of black ducks and percentage change between years

Area-year comparisons	Characteristics compared				Comparability index[1/]	Percent change ducks per segment
	Pairs	Singles	Threes	Flocks of 5 or more		
Southern Zone						
1955-63	2	2	1	2	7	-15
1955-64	2	1	1	2	6	+16
1956-63	2	2	2	2	8	- 8
1956-64	1	1	2	2	6	+26
Central Zone						
1955-63	2	2	1	1	6	-13
1955-64	2	1	0	1	4	-28
1956-63	1	2	2	2	7	-21
1956-64	1	1	1	2	5	-34
Northern Zone						
1955-63	1	1	2	1	5	+72
1955-64	2	2	1	1	6	-10
1956-63	1	0	1	1	3	+91
1956-64	1	1	0	1	3	0
1955-56						
Southern Zone	2	2	1	2	7	- 8
Central Zone	1	2	1	1	5	+ 9
Northern Zone	2	1	1	2	6	-10
1963-64						
Southern Zone	2	1	2	2	7	+38
Central Zone	2	1	1	2	6	-17
Northern Zone	1	1	1	0	3	-48

[1/] Index of 8 indicates highest degree of comparability with regard to grouping characteristics.

Table 3.--Black duck population trends from several indexes

Source	Index and percent difference from 4-year mean			
	1955	1956	1963	1964
Winter Survey - Atlantic Flyway (thousands)	582.5 (+37)	424.8 (0)	325.2 (-23)	366.3 (-14)
Winter Survey - Atlantic Flyway north of Maryland (thousands).	224.9 (+18)	179.7 (-6)	157.0 (-18)	201.6 (+6)
Breeding Population Survey - segments matched in 1955-56 and in 1963-64 (ducks per segment)	1.32 (0)	1.43 (+8)	1.49 (+12)	1.06 (-20)
Group Characteristic Procedure (reference numbers)1/	10,385 (+11)	9,615 (+3)	7,310 (-22)	10,090 (+8)

1/ These values were created, for computation purposes only, from percentage changes. See text for details.

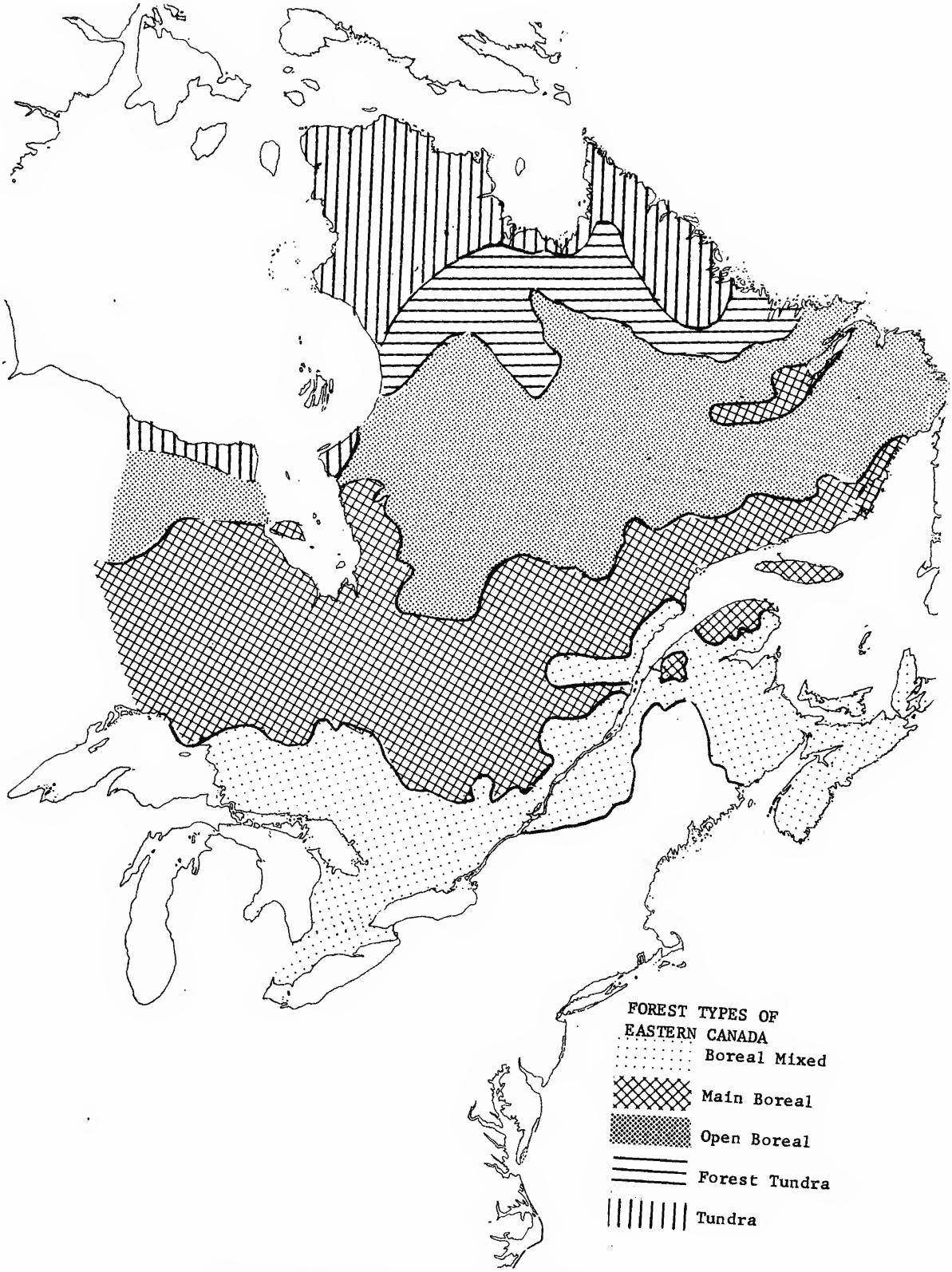

Figure 1.--Forest types of eastern Canada.

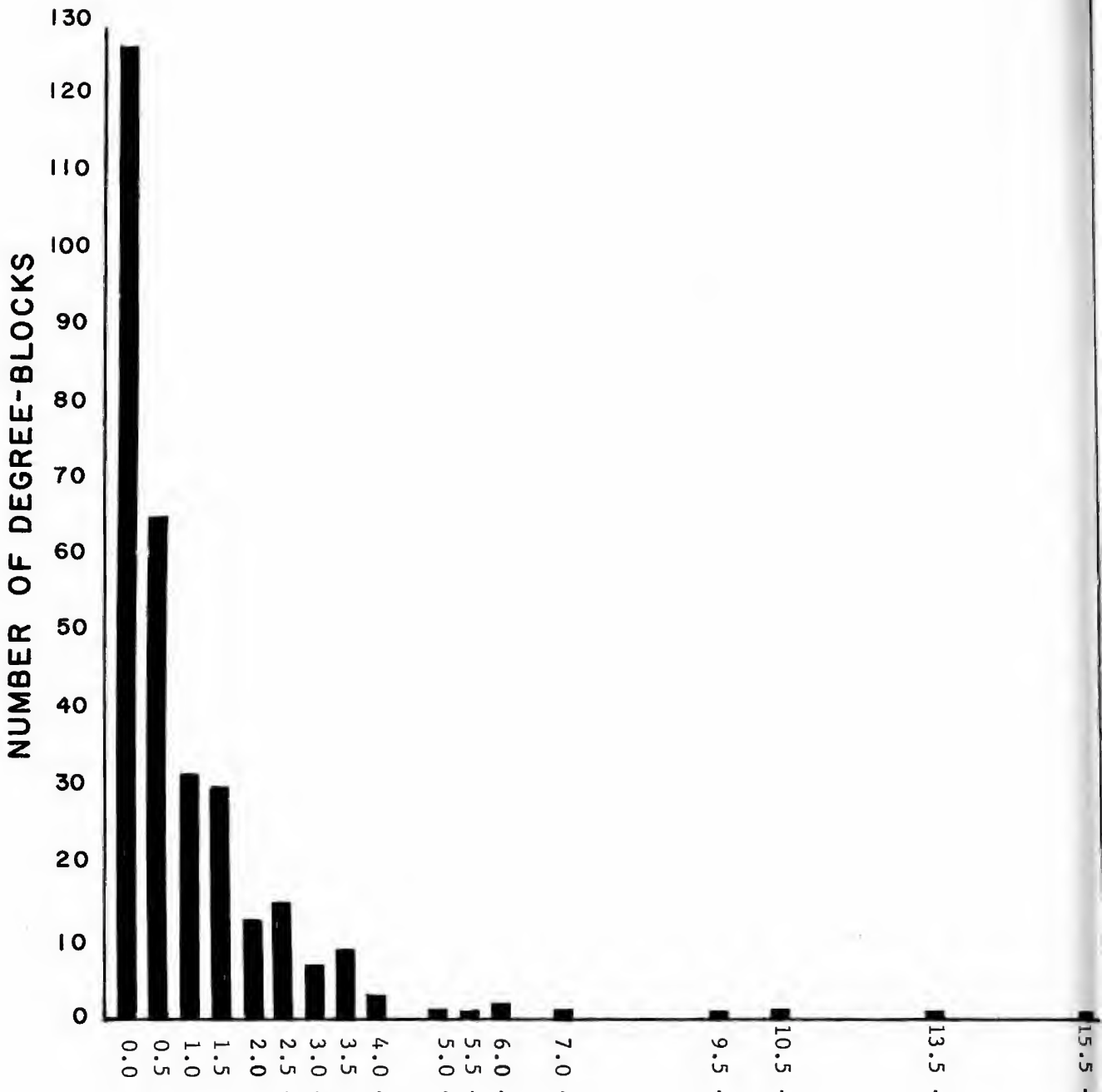

Figure 2.--Frequency with which degree blocks contained given densities of observed black ducks. Data from 1955, 1956, 1963, and 1964 combined.

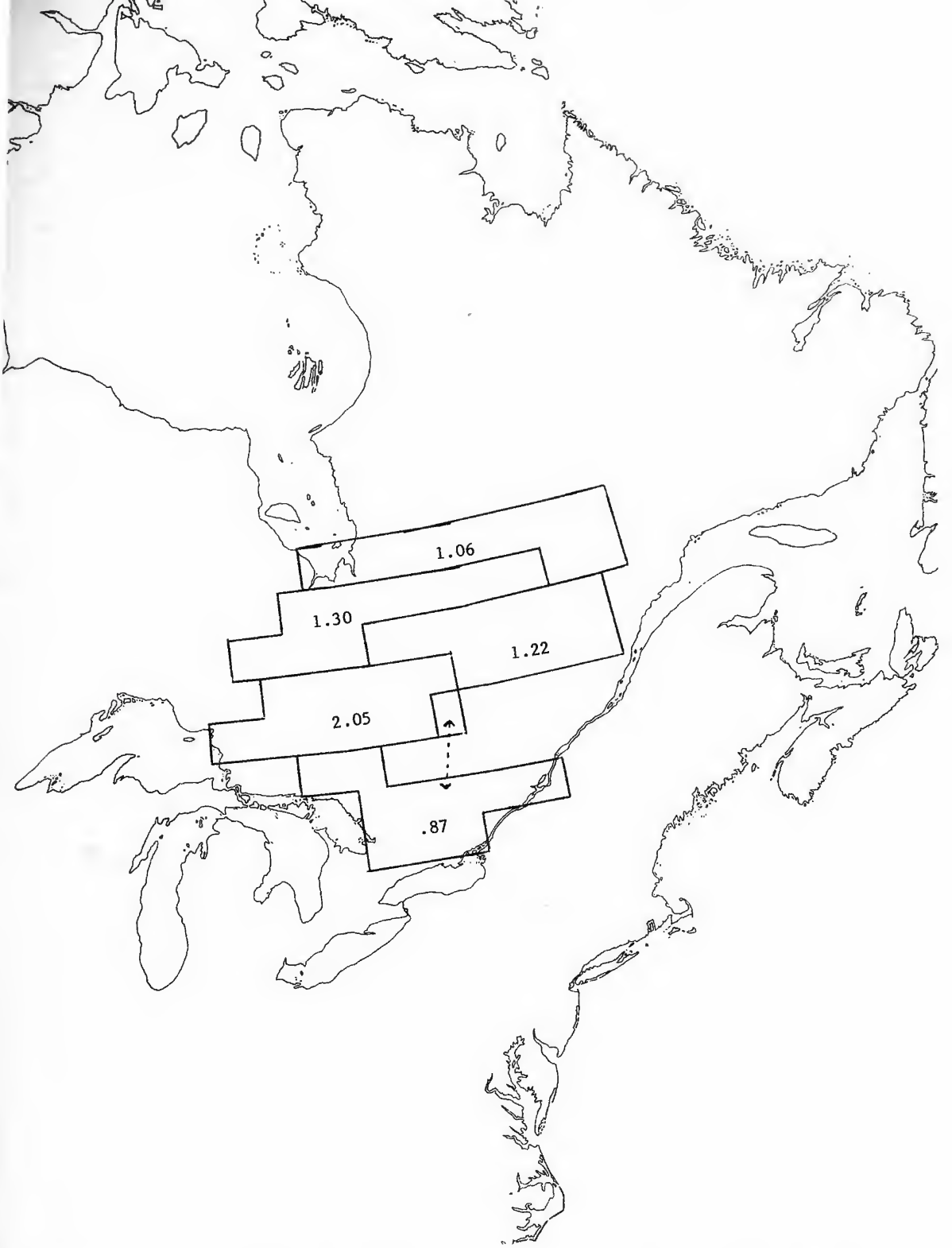

Figure 3.--Most significant density distribution pattern of observed black ducks based upon analysis of variance of five possible patterns in grouping degree blocks. Numbers are ducks observed per 18-mile transect segment (4.5 square miles). Data are from the combined years of 1955, 1956, 1963, and 1964.

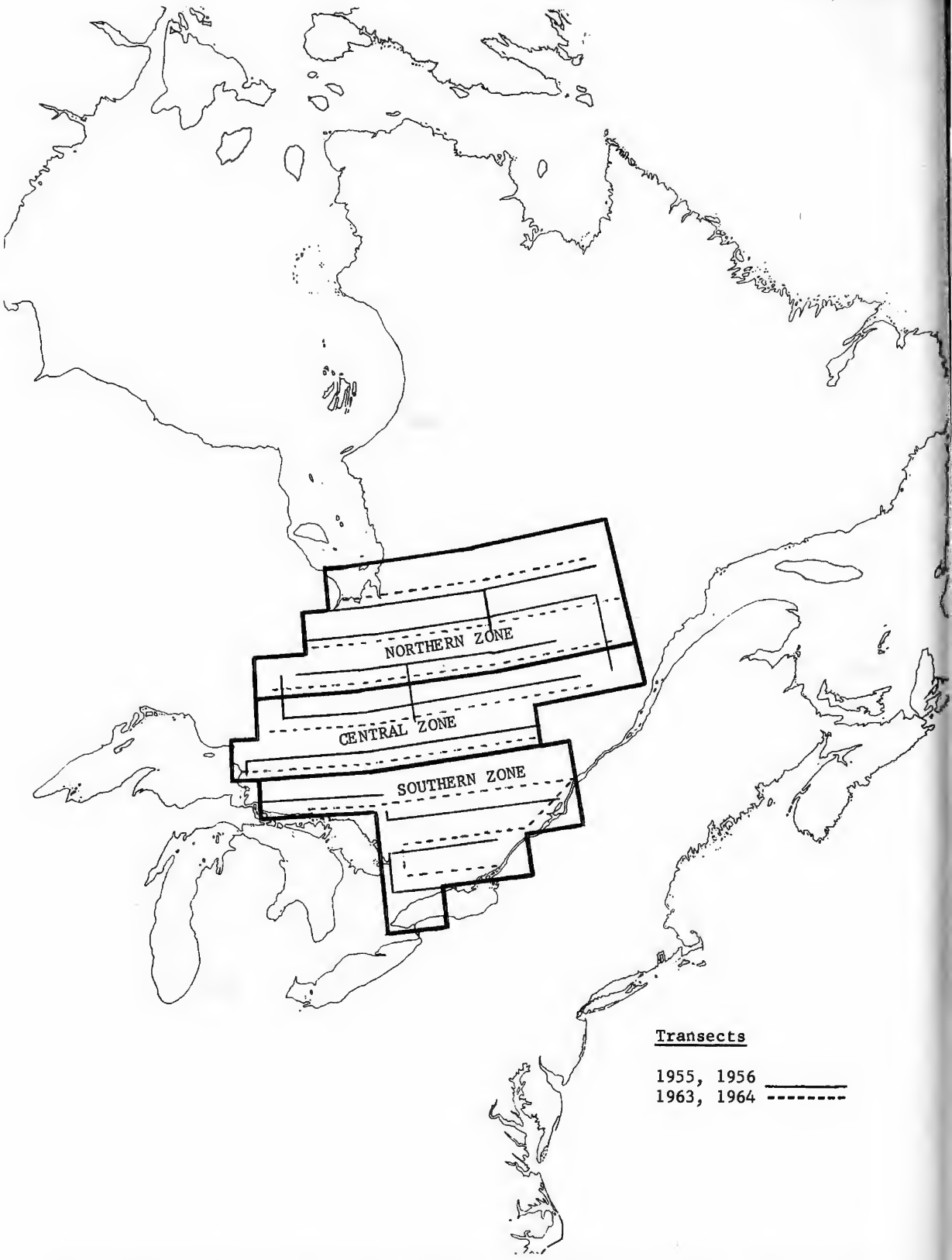

Figure 4.--Zones and transects used for phenological examination of black duck data.

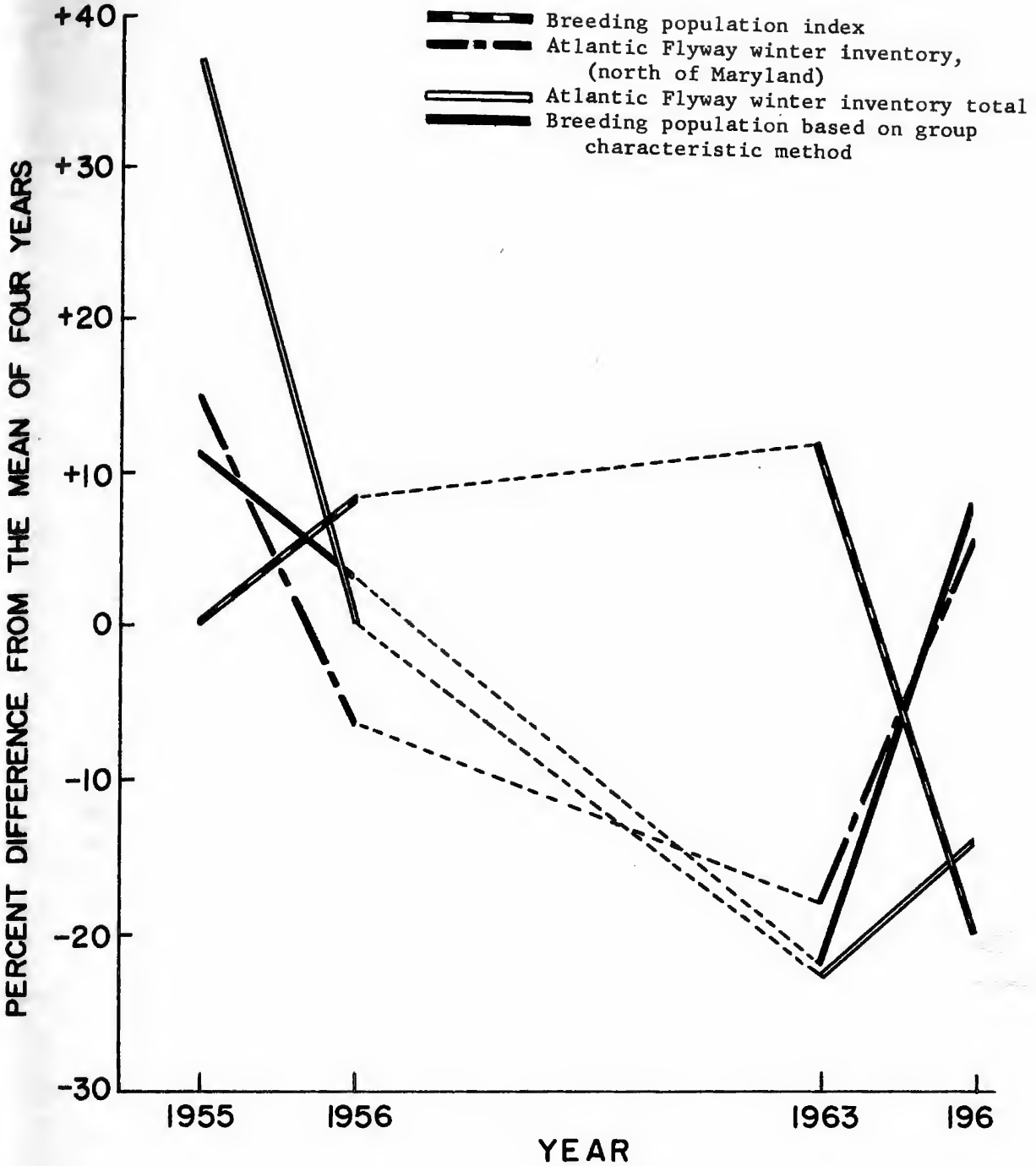

Figure 5.--Black duck population trends for 1955, 1956, 1963 and 1964 based upon breeding ground and winter survey aerial data.